

CHAPTER 5

ELECTRICAL

5-1. General. Electrical system design for buildings located in arctic and subarctic regions require some special considerations. The following items require special treatment.

5-2. Grounding. It is very difficult to obtain an effective electrical ground in arctic and subarctic regions because of soil and climatic conditions. The chance of finding and developing a low resistance grounding site decreases greatly with movement towards polar regions from the zone of seasonal frost, to discontinuous and then into continuous permafrost. Large seasonal variations in the resistance to ground can be expected in areas of frozen ground. Grounding may not be difficult during summer months, but will likely become a problem during the winter with seasonal freezing of the surface layer. Poor grounding results from an arid climate, permafrost, and glacial till or other well drained soils. The normal practice is to ground at the service entrance to the metallic water system piping. If satisfactory metallic water piping is not available, a driven ground rod with a maximum allowable resistance of 25 ohms is required. If this 25-ohm requirement is not met with one rod, up to three additional rods spaced a minimum of 10 feet apart should be driven to bring the resistance down. Ground resistance can also be reduced by increasing the length of the ground rod. If these measures fail to reduce the ground resistance sufficiently, the soil around the rod may be chemically treated. Chemical treatment is a temporary measure and must be repeated periodically, with the time between treatments depending on the rate of leaching by ground water. An effective ground cannot be achieved if the ground electrode is completely enclosed in frozen soil. If a low resistance ground is vital in areas where the soil is subject to freezing to great depths (8 feet or more), other methods of reducing ground resistance, such as construction of ground wells or counterpoises are necessary. Natural thaw zones beneath lakes and streams, the ocean, steel reinforcing bars, or metal well casings can provide good grounding alternatives. In the final analysis, it may be impossible to achieve an adequate ground because of ice and snow cover. In that case, electrical hazards may be minimized by obtaining surface area contact with the earth, or bonding all electrical equipment. Using either method, extra safety precautions should be taken.

5-3. Lighting. The design of interior illumination for any heated building in arctic and subarctic regions is the same as for other regions. In general, lighting intensities should be as recommended in the Illuminating Engineering Society (IES) Lighting Handbook, subject to modifications and clarifications specified in AFM 88-15. The type of lighting must be coordinated with the architectural design to achieve the best psychological effect, as noted in Chapter 2 of this manual. Where low ambient temperatures will normally be encountered in interior and exterior areas, fluorescent or high intensity discharge type lighting fixtures with low temperature ballasts should be used. On an economical basis, selection will be made by comparing initial installation versus relamping maintenance costs. In design analyses, lighting loads will be used with 100 percent load factor.

5-4. Wiring methods. Except for the special requirements discussed below, wiring will be installed in accordance with guide specifications. Conduit runs will be installed to provide sufficient water drainage. Where fittings are installed on surface mounted raceways on exposed walls or floors, the roofs of heated buildings, or in areas exterior to heated buildings, they will be of cast metal. Where outlet boxes are installed flush with the exposed exterior surfaces of heated buildings, they may be of sheet metal with gasketed cast metal covers. Exterior wiring will consist of insulated conductors installed in zinc-coated rigid steel conduits.

5-5. Vapor retarder penetrations. Frost buildup from moisture condensation on the heated side of roofs, exterior walls, and floors must be prevented to the maximum practicable extent wherever electrical wiring penetrates the vapor retarders of these surfaces. The following steps must be taken:

- a. Conduits will be sealed, including interior voids between conductors and cables, and exterior voids between raceways and building components.
- b. Flush mounted boxes will be sealed for the full width and depth of voids between boxes and building components.
- c. Hack-to-back installation of boxes and equipment will not be permitted in roofs, exterior walls, or floors.
- d. On the warm side of boxes, vapor retarder and insulation will be compressed as required without fractures.

e. Nonhardening material will be used for sealing raceways and boxes so that it can be moved without damaging electrical wiring, raceways, boxes, etc.

f. Vapor retarder will be sealed to boxes and equipment wherever practicable.

g. Boxes and raceways will be installed on the warm side of vapor retarder where practicable.

5-6. Electrical insulation. The insulation on electric wires will be of cross-linked polyethylene, or silicone rubber, or other moisture-resistant type that has been proven satisfactory for arctic low-temperature use.

5-7. Switches. Some switches are affected by the ambient temperature. Mercury switches should not be specified for use where the temperature drops to 400 F, as mercury solidifies at this temperature, and switches will not function.

5-8. Miscellaneous items.

a. *Thermally operated protective devices.* A thermally operated protective device is located such that the ambient temperature is approximately the same for the device and the conductor; therefore, low temperatures are no problem. If the protective device is located outside of a heated building and the conductors are inside, however, the temperature differential must be considered. Ambient compensated circuit breakers which are effective to a temperature of about -20°F are available. In unheated areas, enclosures for switches and circuit breakers should be gasketed and weatherproofed to keep the devices moisture free.

b. *Service entrance.* Underground service will be provided wherever practicable. Where required, an overhead service entrance should be located so that it will not be subject to damage from ice forming on eaves. A service entrance should be installed in the gable end of the building or on the roof by bringing a conduit up through the roof overhang and mounting a weatherhead on top. The gable location is preferred because of flashing and support problems introduced by the roof penetration.

c. *Transformer vaults.* In some subarctic areas, corrosive conditions resulting from wind driven rain, snow, and salt spray are so severe that it is desirable to provide vault space inside buildings for transformers and associated service equipment.